From: Anisa Divine
Sent: Wednesday, October 22, 2003 1:10 PM
To: Dabbs, Paul; Guivetchi, Kamyar
Cc: Mike Wade (E-mail)
Subject: FW: Ag WUE re-vision

As has been promised, please advise the Ag Caucus what part of our recommendation for changes to this table has been accepted. Note that this was submitted on August 19, 2003 -- some very small portions have found their way into the Stakholders Draft.

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Agricultural Water Use Efficiency

Agricultural water use efficiency efforts involve technology and/or management changes by the agricultural water user that result in benefits to water supply, water quality, and/or the environment. In 2000, California's net irrigated irriages acreage (counting double- or triple- and inter-cropped land) was 9.6 million acres crops, to which approximately 34 million acre-feet of water (checking). The net water savings possible from agricultural water use efficiency efforts by 2030 is estimated to be xx to yy acre-feet per year with an annual cost of $xx to yy, and a total cost of $xx-yy.

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Current Agricultural Water Use Efficiency Efforts in California

Improvements agricultural water use result from meeting soil and crop wter requirements. This can be achieved primarily from efforts in three related areas:

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a) improving on-farm irrigation application and district water delivery systems through design and installation of appropriate technology (this includes laser leveling, and basin, border, and furrow design in areas where surface irrigation is appropriate): **hardware upgrades**

b) meeting soil and crop requirements through district delivery and grower water application and drainage, including irrigation scheduling, salinity control, land preparation, and reduction in crop and non-crop water consumption: ; **system management**, and

c) modifying crops and soils to use less water, developing new procedures for delivering water and managing salinity: **science** such as biology, chemistry, biochemistry, agronomy, etc.

d) keeping records and learning: **information** that results from data collection, management and reporting

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a. Hardware Upgrades

On-Farm: The majority of acreage in the State is irrigated using surface or sprinkler methods. However, the majority of orchards and vineyards, as well as some annual fruit and vegetable crops, in the State are under pressurized irrigation systems. Almost almost all trees and vines established during last five to ten years receiving drip irrigation. Between 1990 and 2000, acreage with drip irrigation in California grew from 0.8 to 1.9 million acres, of this 1.78 million acres are in tree and vine crops (see below). – **NOTE:** This begs the question of the potential for additional technology improvements on the remaining 50% of land that is surface irrigated and the 29% that is sprinkler irrigated.

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Irrigated Acreage (in million acres)

	1990		2000		% Change
Irrigation method	Acreage	% of Total	Acreage	% of Total	Total Acreage
Gravity - furrow, border, basin	6.5	67.5%	4.9	51.3%	-16.2%
Sprinkler	2.3	23.8%	2.8	28.8%	5.0%
Drip/micro	0.8	8.7%	1.9	19.9%	11.0%
TOTAL	9.6	100%	9.6	100%	0%

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source: DWR

Provide crop data here; State acreage of field crops; fruit & veg crops; flowers & ornamentals; nuts & vine crops - & what % of each is under what type of irrigation**. Indicate how much orchard & vineyard acreage** was established in the last 5 to 10 years, and how much is land that was previously not irrigated – what crops how much acreage – have been taken out of production, & why).

District: The shift to pressurized irrigation systems (sprinkler, drip and micro-spray) often requires modernization of water delivery systems. A shift to increase delivery flexibility requires the same types of modification. Increasingly, irrigation districts are upgrading and automating their systems to enable precise, flexible, and reliable deliveries to their customers. They are reducing system non-recoverable evaporation, seepage and spill by lining canals or converting to pressurized pipe systems, developing spill recovery and tail water return or canal interceptor systems; improving the efficiency of pumps; and implementing conjunctive water use programs.

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Advance technologies in use include GIS, GPS and satellite crop and soil moisture sensing. The satellite-based technologies allow growers to improve their precision to the level of 30-by-30 meter fields rather than 40 or 80 acre fields. The technology and its application are, however, expensive

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b. System Management

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Both district and on-farm operations must be managed to take advantage of hardware improvements.

Districts are training and managing staff to efficiently operate and take advantage of new technology and to better use older technology to provide high levels of service at fair and competitive prices. As part of this effort, they are collecting and using data to improve management capacity in all levels of their organizations.

Modern growers employ evapotranspiration and soil moisture data for irrigation scheduling and use sophisticated automated and computerized irrigation systems for irrigation, fertilizer, and pest management. Real time satellite weather information and forecasting capability systems are used for irrigation scheduling. Users generate over 70,000 inquiries per year to the California

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Irrigation Management Information System (CIMIS), the Department of Water Resources' weather station program that provides evapotranspiration data. Universities, districts, and professional consultants who make these inquiries make this information available via newspapers, websites, and other media to a much wider grower audience.

In addition, those who irrigate by gravity employ laser leveling and engineered furrow, basin and border designs to ensure that water application meets crop and soil water requirements. Modern methods to determine areas of soil salinity are employed, and tile drains are installed so saline water that would be detrimental to the crop can be discharged into collector drains.
Growers use other methods and technologies to schedule their irrigation as well and some districts provide a Mobile Lab service to provide in-field evaluation of irrigation systems coupled with irrigation management recommendations.

Management efforts can include reducing evapotranspiration (the amount of water that evaporates from the soil or transpires from the plant) by reducing unproductive evaporation (water that evaporates from the soil surface); altering plant water requirements through genetics (plant breeding); shifting crops (to plants that need less water); or practicing deficit irrigation, whereby less water is applied than the crop needs.

Presently, the most promising avenue to reduce evapotranspiration on a large scale appears to be through the reduction of transpiration; although the application of drip in the cases. (**Please validate the previous statement – find out how much tree & vine growers already use this procedure)**In most cases, deficit irrigation is practices to improve the quality or to induce maturation of the crop. During extreme dry periods (droughts), deficit irrigation may be practiced to reduce overall agricultural water use. However, in these cases, growers experience a drop in crop yield and/or quality.

(regulated deficit irrigation- see sidebar.) Insert as sidebar

Regulated Deficit Irrigation (RDI) is an irrigation management strategy that purposely stresses trees or vines at specific developmental stages to reduce crop water use, improve crop quality, decrease disease or pest infestation and/or reduce production costs without reducing yield or profits.

Traditional irrigation management strategy is to avoid crop water stress. RDI is used primarily on tree and vine crops where crop quality as well as yield is of primary concern. RDI is a relatively new research area in California, being been conducted on wine grapes, prunes and pistachios for the past ten years. Less research has been done on almonds, citrus, peaches, olives, apples, pears and walnuts. RDI has begun to be widely accepted in wine grapes with wineries and other trade groups promoting the irrigation strategy. To some extent, this is true for pistachios as well. RDI has not **been** widely used yet with any other crops in

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***c. Reducing Evapotranspiration*¶**
Evapotranspiration is the amount of water that evaporates from the soil or transpires from the plant. A grower can
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California. For more information, see R&D Narrative

c. Science – Through biology, chemistry, biochemistry, agronomy, etc. crops and soils may be modified to use less water, new materials may be developed for canal lining, and satellite images may be used to determine crop and soil moisture characteristics. In addition, research on sub-surface drip irrigation on alfalfa at the Irrigated Desert Research Station near Brawley, CA, shows that, while water use is not significantly reduced, yield increased from 19% to 35% (*Subsurface Drip and Furrow Irrigation Comparison with Alfalfa in the Imperial Valley*, Hutmacher, et.al.) by up to 35%. **NOTE: this is the type of practice Dr. Burt of ITRC was reporting in his presentation – not reduced ET.**

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d) Information – Successful water use efficiency programs require that data be collected, managed and reported. In this way, districts and growers are able to determine what programs are providing desired results and which should be dropped (this was the case in the IID/MWD program). In addition, districts and growers will learn to manage their systems better when they have feedback from data they have collected and reviewed.

Even with efforts that are in place and those presently underway, there is still a great opportunity for on-farm irrigation and district water delivery system design and hardware improvements. However, costs and environmental impacts may prove to be of concern to those who would avail themselves of the water that

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Potential Benefits of Agricultural Water Use Efficiency

***Note:* DWR staff is currently working with stakeholders to estimate 2030 water savings and costs by xx,xx,xxx.**

Overall, on-farm improvements in water use efficiency can benefit farmers by increasing net profit, reducing applied water, reducing groundwater overdraft, increasing yield, improving crop quality, lowering the cost of inputs, and potentially profiting from the sale of the conserved water. On the other hand, increased cost may actually or be perceived to outweigh benefits to the user; thus, data are required to determine the cost and returns of these potential benefits.

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District water system improvements can benefit districts by increasing their ability to provide the highest quality service to their customers, both by increaseing delivery flexibility and by reducing non-recoverable seepage, evaporation and operational spill. At the same time, district officials are elected to provide the erivce at a fair and competitive price. **from Lloyd Fryer [Note: this is not really a WUE issue as much as it is a cost savings practice. If the sentence is left**

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in, it should be explained that shifting to off peak could result in cost savings (although the same would be true even without WUE).

Environmental benefits may include water quality improvements **(WHERE & WHAT)** as well as reduced drainage as surface runoff is lessened through implementation of programs to limit TMDLs (Total Maximum Daily Loads), increased stream flow and improvements in temperature and timing. Improvements in agricultural water use efficiency can cause negative environmental effects, such as reduced runoff to water bodies downstream.

The multiple benefits associated with agricultural water use efficiency in key agricultural regions (the Sacramento and Central valleys) have been evaluated by CALFED and described regionally from a watershed perspective as 'quantifiable objectives'. While California is striving to meet its CALFED goals **(CA does not have to meet its CALFED goals, it does have to reduce its COR use)** California must reduce its use of Colorado River water from 5.2 million acre-feet per year to its 4.4 million acre-feet per year allocation.

Placeholder: In 2000, CALFED estimated the net water savings associated with improved agricultural water use efficiency to be 206,000 to 565,000 acre-feet per year including on-farm and district level actions. The CALFED estimates include improvements in irrigation hardware and scheduling, but not reductions in evapotranspiration. Total estimated net water savings associated with improved water use efficiency, therefore, would be from xx to yy million acre-feet.

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Potential Costs of Agricultural Water Use Efficiency

Place holder: The CALFED Record of Decision estimated water savings at two levels of expenditures. The first level results when growers and water districts implement efficient water management practices as a part of their standard operation. This level estimates net water savings of 118,000 to 322,000 AF per year at a cost of $35 to $ 95 per acre-foot. The second level results from the investment of funds by the State and Federal agencies with net savings ranging from 88,000 to 243,000 AF per year at a cost of $80 to $900 per acre-foot. CALFED, therefore, identified a total of 206,000 to 565,000 AF of net water savings per year at a cost of $110 to $1000 per af/year. The cost assumes on-farm efficiency of 85%.

Sidebar **IID/MWD Transfer Summary by Project ($1988)**

	Projected 1999 Water Conservation		
Project	**AF [1]**	**Cost $/AF [2]**	**Intervention**
Robert F. Carter Reservoir	4110	$0	hardware
South Alamo Canal Lining Phase I	510	$0	hardware
Plum-Oasis Lateral Interceptor	9,000	$69	hardware
Trifolium Lateral Interceptor	14,560	$81	hardware
Mulberry-D Lateral Interceptor	8,500	$102	hardware

Galleano Reservoir	4,470	$48	hardware
South Alamo Canal Lining Phase II	900	$110	hardware
Lateral Canal Lining	24,250	$127	hardware
Vail Supply Canal Lining	10	$1,247	hardware
Rositas Supply Canal Lining	130	$323	hardware
Westside Main Canal Lining	260	$536	hardware
12-Hour Delivery	21,750		management
Singh Reservoir Improvements		$57	hardware
Non-Leak Gates	630	$37	hardware
Irrigation Water Management	280	$787	hardware
System Automation	14,600	$125	hardware
Additional Irrigation Water	4,540	$111	hardware
Program Coordination and Verification			management & information
Pinto Wash Reservoir; WSM Canal Seepage Recovery; EHL Canal Seepage Recovery [3]			
Insurance [4]			management

TOTAL PROGRAM COSTS

Capital (1988$); 1999 O&M (1988$)	$96,455,287	$4,147,699
Total 1999 Water conservation AF	**108,500**	
1988$ Cost per AF =	**$127**	

[1] Budgeted O&M and projected water conservation are subject to change each year, which will affect Annual Cost per AF

[2] Without pro-rata share of Project Management and associated verification costs, which costs are included in Total Program Cost per AF; Carter Reservoir & So Alamo Phase I were completed by IID prior to the IID/MWD program with, water savings were credited to MWD

Cost per AF is calculated based on 43.75-year period, total construction phase (8.75 years) plus O&M (35 years), with an 8% discount rate. Capital Recovery Factor = 0.08285 (43.75 years at 8%)

[3] Capital expenditures for studies of potential completion projects not required to meet Program water conservation objectives

[4] Program costs for insurance through 35-year operation and maintenance agreement period

Major Issues Facing Additional Agricultural Water Use Efficiency

The major issues related to improving agricultural water use efficiency in California are related to:

1. funding;
2. implementation;
3. measurement, planning and evaluation;

4. education and motivation;
5. innovation; and
6. dry year considerations.

1. Funding

Additional funding is needed for agricultural water use efficiency projects. Funds dedicated to water use efficiency have fallen well below commitments made in 2000 through the CALFED Record of Decision that called for an investment of $1.5 billion to $2 billion from 2000-2007. State and federal agencies committed to funding 50 percent (25 percent each) with local agencies funding the remaining 50 percent of water use efficiency activities. State and federal expenditures are listed below. To date, no evaluation has been made of local investments in water use efficiency.

ROD Expenditure Projections, including State, federal and local shares and Actual State and federal Expenditures to Date (in $ millions)

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Year	2001	2002	2003	2004	2005	2006	2007	Total
ROD	31	62	299	641	641	641	641	2,956
Actual	?	?	?	?	?	?	?	?

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Presently, through the Agricultural Water Management Council's (AWMC) Memorandum of Understanding (MOU), local agencies have committed to funding cost-effective Efficient Water Management Practices (EWMPs), where the B/C > 1.0 at the local level. However, water transfers is an EWMP, in which case the B/C would apply at a level that is larger than the local level.

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State, federal and international programs, on an irregular basis, provide a source of funding for the EWMPs beyond the MOU level, for actions other than standard EWMPs, and for those EWMPs that may not be locally cost effective.

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While the initiative process has provided State funding for water use efficiency projects through Propositions 13 and 50, retaining a sufficient State and federal expertise to administer the programs and provide financial and technical assistance in this field is not easy with across the board budget and staff cutbacks. Irrigation districts also face increasing challenges to implement water use efficiency actions and to maintain a permanent expertise or institutional continuity with limited staff and budgets. **(anisa: this is not my experience)**

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Investments in research and demonstration are critical. Substantial financial support for research, development and the demonstration of efficient water management practices in agriculture has come and continues to come from the agricultural industry. Support also comes from the early adopters of new

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technology who often risk their crops, soils and dollars when cooperating to develop and demonstrate technology innovations.

Grant programs may miss the opportunity to fund worthwhile projects in small and disadvantaged communities; however, the Resource Conservation District and Resource, Conservation and Development programs are designed to alleviate this situation. Such communities often find it difficult to compete for limited grant funds, although their needs are often great. The impact on farm workers is often neglected when considering different approaches to water use efficiency.

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In some areas of the State, funding for water conservation comes from the ability to transfer water. Funds from these programs are expected to continue to play a significant role in financing future water use efficiency efforts.

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2. Implementation

Much has been accomplished, but still more might be done to increase agricultural water use efficiency and optimize agricultural profits per unit of water without compromising the economic viability of California's agricultural productivity and its water quality or the environment.

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The Agricultural Water Suppliers Efficient Water Management Practices Act of 1990 (AB 3616) and the Central Valley Project Improvement Act (CVPIA) established a framework for improving agricultural water use efficiency in concert with maintaining and/or improving environmental values. Developed under AB 3616, over 55 California water suppliers (both retail and wholesale) have entered into a voluntary and cooperative Memorandum of Understanding Regarding Efficient Water Management Practices (EWMPs) by Agricultural Water Suppliers. The retail districts, comprising over 3.65 million acres of irrigated agricultural land statewide, are committed to developing water management plans and implementing cost-effective EWMPs. The California Agricultural Water Management Council oversees the progress of water management planning and the implementation of EWMPs.

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Ag Water Management Efficient Water Management Practices (EWMPs)	
1. Facilitate Alternate Land Use	management
2. Facilitate Use of Available Recycled Water	technology
3. Facilitate Financial Assistance	management
4. Facilitate Voluntary Water Transfers	management
5. Line or Pipe Ditches/Canals	technology
6. Increase Water Ordering/Delivering Flexibility	technology
7. Construct/Operate Tailwater / Spill Recovery System	technology

8. Optimize Conjunctive Use	technology
9. Automate Canal Structures	technology
10. Water Measurement/Water Use Update	technology & information
11. Pricing and Incentives	management

While a number of water suppliers have not joined the MOU (small districts often do not have the technical and financial abilities to develop plans or implement efficient water management practices), 30 out of the 55 member districts have submitted plans and have already or are in the process of implementing all cost-effective EWMPs (B/C > 1). Other districts are pursuing water transfer and other funding options to implement EWMPs thar are not locally cost effective. Districts and growers will implement the remaining EWMPs as the cost-effectiveness changes due to reduction in the cost of technology, or as new, less expensive technology becomes available. Alternatively, districts will implement additional EWMPs as partners are found who are willing to pay the cost of the EWMP through voluntary transfers, or as funding becomes available through programs such as Proposition bond measures, CALFED, NADBank or other sources.

Opportunities exist beyond the implementation of EWMPs that could result in major improvements in water use efficiency. These include emerging and as yet unimagined methods and technologies that can be expected to significantly increase conservation potential. For now, such practices include satellite-based management at as 30-meter level as well as expanding satellite based management and computer-decision support systems, as well as productivity gains through drip.

The CALFED Record of Decision of 2000 (ROD) further institutionalized agricultural water use efficiency. State and federal agencies are committed through the ROD to provide financial and technical assistance to local agencies for the implementation of water use efficiency measures. However, funding has proven to be problematic.

***a. Hardware Upgrades* / 5. Innovation**

New cost-effective agricultural water conservation technologies and are expected to be developed over time that will help districts and growers meet the demand for water. For example, the water-saving, weather-based controllers that are becoming increasingly popular in the urban sector may have an important role to play in the agricultural sector as well. By establishing an atmosphere where growers and districts can pursue new methods while keeping production risks to a minimum, these practices will be adopted.

Due to system limitations, growers are often unable to apply the exact amount of irrigation water when the crop needs it. Water system improvements such

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canal automation, regulating reservoirs, as integrated supervisory control and data acquisition systems (SCADA), and other hardware and operational upgrades could provide flexibility to deliver the water when and where it is needed in the appropriate quantities. Thus, development and operation of irrigation and distributions systems to increase delivery flexibility can significantly improve water use efficiency.

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Growers have made and continue to make significant investments in on-farm irrigation system improvements. In terms of future improvements, the Cal Poly Irrigation Training and Research Center estimates that 3.8 million acres could be converted to precision irrigation such as drip or micro-spray irrigation. While this may not reduce crop demand, it would could improve the distribution uniformity of water applied, reduce non-beneficial evaporation losses, and thus allow the grower to apply less water to the field. At the same time, crop water use could be more closely matched with resulting improvement to crop yield and quality. Research has show water application reduction at 2% to3 %; however, yields increased from 19% to 35% (Note this is a repeat of from Desert Research Station). Dr. Burt said we would use the same amount of water but that productivity would increase 30%.— I am checking w/Burt to see if he was using the same report).

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b. System Management

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Districts are using tools including automated gates operated using SCADA systems, along with computer-based monitoring equipment, including workstations, map boards, file and database servers, and centralized communications equipment. Personal computers connected to real-time communication networks and a local area network will allow free flow of information from the field to any workstation computer. These features enable district staff to monitor flow, provide setpoints, exert supervisory control over each field site, and log data on a continuous, electronic basis.

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Online programming, data analysis and a variety of other functions can be performed using real-time or archived data. In addition, the computerized systems support supervisory control, graphics, trending and alarming; data acquisition; systemwide mapboard display; as well as remote site configuration, programming and troubleshooting. Data are backed up daily on cassette tape for archival and security purposes.

With such systems, district staff spends less time monitoring and manually controlling individual sites, allowing them to plan and operate the system in a strategic and integrated manner. This facilitates a systemwide view along with improved reliability of the communications system.

Growers on the cutting edge of technology are using GIS, GPS and satellite-based management tools to determine where and when to irrigate their crops. More traditional growers use CIMIS, soil proves and other irrigation scheduling tools. To the extent that districts can provide water to growers with sufficient flexibility to meet soil and crop water requirements, efficiencies resulting from on and district management can be expected to increase.

c. *Science*

To promote agricultural water use efficiency, efforts cam be dedicated to researching and promoting ways growers can reduce evapotranspiration and districts can reduce non-recoverable evaporation, seepage and operational spill. Other areas of promising research include irrigation technologies that increase crop yield and quality even when using the same amount of water.

d) Information / 3. Measurement, Planning and Evaluation

Measurement of water and associated information provided to the water district operations staff and to the grower are essential to obtain efficient water management. Without measurement of water as it moves through the district and farm systems, neither the district nor grower , will be able to manage water efficiently. Likewise, without measuring changes in use or productivity, the efficacy and cost of proposed efficiency measures cannot be evaluated.

Documenting water savings and costs related to the various programs rests on the ability to track water use. According to the CALFED Appropriate Water Measurement Panel, nearly 100 percent of the major surface water diversions to agricultural water uses are measured. However, less than one-third of groundwater use is measured **(?? Is this ag use, or also urban)** EWMP 10 of the AWMC MOU requires water measurement improvements only if water conservation can be shown. However, the CVPIA and other federal water contracts require the contractor to measure water use and to bill by volume.

DWR lacks sufficient statewide comprehensive data on the acreage under various types of irrigation systems, methods of irrigation, amount of applied water, crop water use, cultural requirements, irrigation efficiency, accurate measurement of water use and net water savings, and the cost of district and on-farm irrigation improvements. As such, DWR is restricted in assessing current irrigation efficiencies and planning for further improvement. Collection, management and dissemination of such data to growers, districts, and State planners are necessary for promoting water use efficiency.

Information on the effect of reducing non-productive evaporation and reducing crop evapotranspiration is lacking. Similarly, more information about potential savings associated with controlled crop dry-down of alfalfa (where growers forego the late summer cuttings of alfalfa in order to use that water on another field or for a voluntarily transfer water), or alternative land use in a voluntary and compensated program during dry years would assist planners at all agency levels..

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Use of pressurized irrigation systems has recently increased and has improved water use efficiency. These systems require energy, facilities, and materials for proper operation. The long-term costs and benefits of these systems merit study.

4. Education and Motivation

Information about why California growers adopted water use efficiency practices and how those practices could be encouraged and sustained are vital to the planning process, as is knowing what types of incentives districts respond best to. What evidence exists indicates a strong response to financial incentives whenever offered in a simple, understandable format and process. Determining which technological changes should be pursued for short-term situations (during water shortages) compared to long-term will be valuable input to increased agricultural WUE.

6. Dry Year Considerations

Measures can and need to be taken in the very near term to prepare for dry years. Agriculture district and growers are often called upon during dry years to refrain from providing water to with compensation for the water not used. Review of traditional approaches **(WHAT are the traditional approaches)** to meet water needs during dry years along with exploration of other approaches, such as an alfalfa summer dry down program, will provide a robust body of information use during future period of water shortage. In addition, the cost to districts and growers must be determined, so water users who place greater value on their desired use of water can compensate districts and growers for this change of use.

Recommendations to Achieve Additional Agricultural Water Use Efficiency

The following actions reflect possible solutions to issues raised in the previous section that can be adopted in concert with other Water Plan Strategies such as Integrated Resource Planning to increase agricultural water use efficiency. To achieve this results, a wide range of strategies will need to be employed including financial incentives, revisions in State and local codes and standards, and legislative initiatives.

1. Funding

1. Secure $XX of funding (?? over the next 30 years) to support ag water use efficiency incentive programs, both implementation and evaluation, and associated expertise at the local level as well as at the State and federal levels.

2. Identify and establish priorities for future grant programs and other incentives.

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New agricultural water conservation technologies and techniques will be needed to meet the demand for water over time. For example, the water-saving weather-based controllers (ET controllers) that are becoming increasingly popular in the urban sector may have an important role to play in the agricultural sector as well. An environment needs to be established where growers and agencies can demonstrate a willingness to pursue new methods while keeping risks to a minimum.

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3. Fund technical and planning assistance to improve water use efficiency including local efforts to implement EWMPs and meet CALFED WUE goals, as well as the implementation of Quantifiable Objectives.

4. Fund research, development, and demonstration projects that could promote improved agricultural water use efficiency.

5. Fund technical assistance programs that encourage growers' use of advances in irrigation systems and management technologies.

2. Implementation

General

1. Encourage additional signatories to the Agricultural Water Management Council's Memorandum of Understanding and full implementation of Efficient Water Management Practices by present signatories. Encourage the addition of new EWMPs as benefits are identified.

2. Employ urban recycled water for agriculture whenever feasible.

6. Work with tribes and community-based organizations to get the word out and assist in the development of proposals.

7. Provide ample opportunities for small districts and economically disadvantaged communities to benefit from technical assistance, planning activities, and incentive programs.

8. Honor environmental justice policies established by funding agencies and others

a. Hardware Upgrades

3. Eliminate or reduce non-recoverable operational spill, seepage and non-beneficial evaporation from district water distribution systems, through canal lining, sytem automation, computerization, etc.

4. Continue upgrade of on-farm irrigation systems to more efficient levels as funding and technology improvements become availble.

b. System Management

5. Modernize water distribution and management systems to improve water delivery flexibility including

6. Expand CIMIS, mobile laboratory services, and other training and education programs to improve irrigation scheduling and efficiency.

c. Science

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7. Provide ample opportunities for small districts and economically disadvantaged communities to benefit from technical assistance, planning activities, and incentive programs.¶
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8. Honor environmental justice policies established by funding agencies and others

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Deleted: ***. Reducing Evapotranspiration***

7. Fund large and long-term RDI demonstration and research plots as well as other promising programs to reduce evapotranspiration. **(BEFORE doing this, research how much of impacted area [vine & trees – 1.78 MAC] are already using this technology).**

X/ FUND long-term research throughout the State on increased yield & quality with same water use through subsurface drip and other on-farm technologies. Find ways to make it cheaper and more grower-friendly.
8. Develop statewide protocols and guidelines **(WHO** are these for – growers or agencies & whatever are they?) to promote implementation by districts and growers.

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3. Measure, Plan and Evaluate

1. Measure water to customer and bill by volume of use with rate structures that encourage water use efficiency.

2. In cooperation with the agricultural community, support scientific research, development, demonstration, monitoring and evaluation components of agricultural water use efficiency technologies and management practices.

3. Collect, manage and disseminate statewide data on acreage under various irrigation methods, the amount of water applied, crop water use, and the benefits and costs of water use efficiency measures.

4. Work with State and federal grant recipients and others to obtain useful and consistent data from funded projects and other activities, including the documentation of sources and methods behind data presented.

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5. Encourage comprehensive planning and implementation of water conservation activities at the agency and regional level.

6. Gather information through surveys and other instruments on how growers use water.

7. Develop comprehensive methodology for quantifying non-recoverable evaporation, transpiration, seepage, tailwater and spill water and for analyzing ag WUE project benefits and costs. **(WE have the methodology – the problem is quantification & data management cost a lot)**.

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8. Couple research and technology development with incentive-based implementation programs.

9. Evaluate the environmental impacts of water use efficiency. Work with enviromental, ag and urban intersts to set up a protocol to resolve these impacts without going to court.

4. Educate and Motivate

1. Develop grower -based social marketing surveys and strategies for conservation activities to foster water use efficiency, with the participation of the agricultural and water industries and environmental interests.

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2. Identify and overcome barriers to improved water use efficiency, communicate the benefits, provide incentives, and gain commitment from all involved. Find the funding…

5. Innovate

1. Research and identify innovative technologies and techniques to improve water use efficiency and develop new EWMPs to correspond with new information.

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2. Fast track pilot projects, demonstrations, and model programs exploring state-of-the-art water saving technologies and procedures and publicize results widely. Keep in mind need to watch for unanticipated impacts, environmental and oterhwise.

6. Prepare for Dry Years and Extraordinary Shortages

1. Have a comprehensive campaign ready to go for next drought.

2. Conduct contingency planning for extraordinary short- and long-term shortages.

3. Realize water market opportunities during droughts.

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4. Support further research in development of strategies for voluntary alternative land use in drainage impaired lands.

5. Support further research in summer crop dry-down and explore incentives for districts and farmers to forego summer cut of alfalfa, and other similar programs.

Side bar:

Regulated Deficit Irrigation

Regulated Deficit Irrigation (RDI) is an irrigation management strategy that purposely stresses the trees or vines at specific developmental stages with the goal of reducing crop water use, improving crop quality, decreasing disease or pest infestation or reducing production costs without reducing yield or profits. RDI was first developed in Australia and New Zealand in the 1980's. Research began in California in the 1990's with initial results showing the potential for significant water savings (a reduction in evapotranspiration) while increasing or maintaining crop profitability and allowing optimum production.

The traditional irrigation management strategy has been to avoid crop water stress. RDI is used primarily on tree and vine crops where crop quality as well as yield is of primary concern. Stress imposed at specific growth stages can improve crop quality, even though it limits or reduces plant growth or development. Wine grapes are a clear example: mild stress imposed through the growing season decreases canopy growth, but produces grapes with higher sugar content, better color and smaller berries with a higher skin to fruit volume ratio.

RDI is a relatively new research area in California. Research has been conducted on wine grapes, prunes and pistachios for the past ten years. Less research has been done on almonds, citrus, peaches, olives, apples, pears and walnuts. RDI has begun to be widely accepted in wine grapes with wineries and other trade groups promoting the irrigation strategy. To some extent, this is true for pistachios as well. It has not been widely used yet with any other crops in California.

Regulated deficit irrigation in particular could result in several possible benefits. First, through increased productivity and efficiency, the economics of tree and vine production could become more profitable. Some crops disease and insect problems could be lessened, decreasing the application of pesticides.

If RDI is adopted by a significant percentage of growers in the State; RDI could result in substantial statewide water savings. Dr. David Goldhamer of the University of California Cooperative Extension has estimated potential water savings ranging from four to 14 inches per year. He then extrapolated the potential statewide savings by applying the crop savings to the approximate crop acreage. The estimated water savings for RDI range from one million to 1.5 million acre-feet per year, per Table 1.

Table 1. Range of estimated net water savings relative to current practices using regulated deficit irrigation (RDI)

Crop	Bearing Acreage	Estimated Savings (inches)	Water Savings (acre-feet)
Almonds	530,000	8- 14	424,000- 618,000
Winegrapes	480,000	8- 12	320,000- 480,000
Citrus	244,000	6- 8	122,000- 163,000
Pistachios	78,000	10- 12	65,000- 78,000
Prunes	76,000	6- 12	38,000- 76,000
Peaches	70,000	4- 8	23,000- 47,000
Olives	36,000	6- 10	18,000- 30,000
Apples and Pears	49,000	4- 8	16,000- 33,000
Walnuts	196,000	Unknown	Unknown
Total	1,759,000		1,026,000- 1,525,000

The cost of RDI is estimated to be $10 per acre-foot per year. (Dr. Goldhamer's basic assumptions for this estimate: 500 acres of trees x 6 inches of savings per year equals 250 acre-feet per year. One temporary help, minimum wage of $6.50/hour, $1000 per month for 2.5 months of the early irrigation season equals $2,500 to take pressure chamber readings, record data, provide to irrigator. $2,500/250 equals $10 per acre foot). Assuming that most tree and vine crops that will be using this strategy are irrigated by drip, other micro irrigation technologies, or other uniform, controllable systems, costs would be limited to irrigation management.

Long term and large-scale studies and demonstration projects need to be conducted before the practice can be promoted and encouraged for commercial production on a wide scale. Areas for further study include: the current extent of deficit irrigation for each crop to verify estimated water savings potential; the potential for increased disease and insects infestations that could limit production and shorten tree lifespan; the potential of RDI on trees to become alternate bearing; and the affect of RDI on crop quality and yield measured over a number of years and during different water years.

RDI may require more management and data collection to support this technique. Technical and economic aspects of RDI need further studies and the development of protocols and guidelines for full implementation by growers.

Sidebar:

Kern County Water Agency reports significant improvements in irrigation efficiency. An analysis of data in 1986 compared to 1975 showed an 8 percent improvement (from 67 percent in 1975 to 75 percent in 1986). This improvement has reduced the total applied water use in the San Joaquin Valley portion of Kern County by about 250,000 acre-feet, enough water to irrigate about 70,000 acres. Since 1986 Kern County has added 61,500 acres of trees and vines. These now make up 37 percent of the total irrigated acreage. Nearly all of this new acreage has low volume "drip" irrigation systems installed. KCWA estimates the overall on-farm water use efficiency now is about 78 percent.

Sidebar:

Irrecoverable versus Recoverable Losses Related to Water Use Efficiency

Irrecoverable Losses: The portion of water that would be lost to a salt sink or to a very deep aquifer; lost to evapotranspiration; or lost to evaporation from a conveyance facility, if not conserved. Generally, conserving irrecoverable losses makes water available for reallocation to other uses. Water conserved by reducing irrecoverable losses is often referred to as “net” or “real” water savings.

Recoverable Losses: The portion of water that could constitute a supply to the downstream user for groundwater recharge, agricultural, urban or environmental water use, if not conserved. Reducing recoverable losses would deplete downstream supplies with no net gain in the total water supply. However, benefits could include improved in-stream and groundwater quality, reduced temperature impacts, and reduced entrainment impacts on aquatic species.

It is often difficult to distinguish between irrecoverable and recoverable water losses, but such a distinction helps illuminate what types of benefits can be associated with water conservation efforts at specific sites.

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Reducing Evapotranspiration

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, surface water diversions remain unmeasured in critical areas of the State.

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Memorandum of Understanding does not